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# STATISTICAL CHARACTERISTIC OF THE IMPACT STRENGTH OF HARDENED GLASS

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A set of statistical characteristics of the strength of hardened glass hit by a ball is considered. It is shown that under the conditions of a plant the asymmetry of the strength of float glass has a tendency to decrease markedly.

The asymmetry in the strength of float glass, including hardened float glass, has been discussed many times [1, 2]. At the same time, the literature does not contain enough data on the statistical characteristics that reflect objectively the properties of parts but are not allowed for in the acting standards.

The present paper is an attempt to fill this gap.

We performed large-scale tests of the impact strength of hardened glass under conditions quite close to those described by GOST 5727–88 but with careful determination of the orientation of the glass during the tests.

We will assume that the contact surface of the glass touches the tin melt in the process of shaping the ribbon, and the noncontact surface lies oppositely and is washed with the protective atmosphere of the float tank.

Specimens $500 \times 500 \times 5$ mm in size were cut from sheets of float glass produced in the two-stage shaping line of the Saratov Institute of Glass. Each surface was identified using a source of ultraviolet radiation and marked by a glass-marking pencil. The specimens were chosen, cut, treated over the edges, and washed at the experimental plant in a conventional production cycle with allowance for the defects accumulated under actual conditions.

Before the specimens were placed into the hardening line the preforms were marked on the noncontact surface and placed on a roll conveyer with the contact side facing downward. The preforms were hardened in accordance with the schedule for large-scale production of parts from hardened glass for the automobile industry.

All the hardened specimens were measured using the parameters regulated by the acting standard and some additional parameters not envisaged by the latter. The first group of parameters included the deviation from the plane, the differences in the thickness, the correspondence to the specified geometrical shape (area), the presence of optical defects, and the nature of fracture. All the specimens met the requirements of the GOST 5727–88 standard. The second group of parameters included the degree of hardening of the specimens $\Delta$ and the surface tension $\sigma_s$.

The degree of hardening was measured for blank specimens 100 mm wide, which were examined through the end face in a PKS-125 polariscope-polarimeter with the use of a set of standard quartz wedges, $\Delta = 2.5 \pm 0.1$ pores/cm. The surface tension was determined using a DSR refractometer (PPG Company, U.S.) by the method of the producer, $\sigma_s = 115 \pm 3$ MPa.

After this we performed full-scale tests of the impact strength of the specimens. The experiment consisted of the following. Hardened full-size specimens were divided into two equal groups with 75 pieces in each group. Half of the specimens were oriented with the contact side facing downward, and the other half were oriented with the contact side facing upward. The conditions of the experiment were as close as possible to the requirements of the standard, but the height from which a 227-g ball was thrown onto each specimens was increased in 10-cm steps until the glass broke.

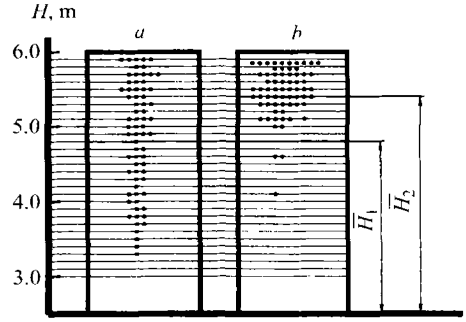


**Fig. 1.** Sampling characteristic of the impact strength of specimens: *a*) the contact side faces downward; *b*) upward.

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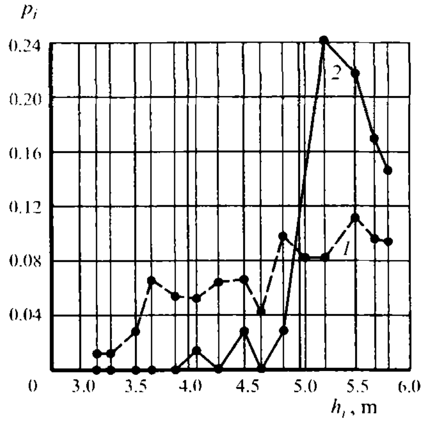


**Fig. 2.** Empirical density of the probability $p_i$ that the hardened glass will have a strength $h_i$: *1*) the contact side faces downward; *2*) upward.

The general picture of the distribution of the heights from which the ball was thrown at the moment of fracture is presented in Fig. 1. It can be seen that the specimens with the contact side facing upward are more strong.

The values of the mean height of fall of the ball as calculated by the formula

$$\bar{H} = \Sigma h_i n_i / n,$$

where $h_i$ is the running fracture height of the $i$th group of specimens, $n_i$ is their number, and $n$ is the total number of specimens in the given series of tests, were as follows: $H_1 = 4.844$ m, $H_2 = 5.430$ m. Thus, the mean statistical asymmetry of the strength was 10.8%.

A fuller characteristic of the impact strength is presented in Fig. 2.

We processed the results to obtain the variance $D(x)$ and the standard deviation $\sigma(x)$, which turned out to be:

$D_1(x) = 0.4823$ and $\sigma_1(x) = 0.6945$ for specimens oriented with their contact side facing downward;

$D_2(x) = 0.6092$ and $\sigma_2(x) = 0.7805$ for specimens oriented with their contact side facing upward.

The coefficient of variation for both cases was 14.35%, i.e., the intensity of scattering of the results for the first and second sets was virtually the same.

The presented statistical characteristics show that the data obtained earlier on the asymmetry of float glass hardened under industrial conditions have been somewhat exaggerated [1, 2]. The difference in the strength does not exceed 11% and can be neglected in glazing actual objects.

## REFERENCES

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